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ABSTRACT

This module provides information on: (1) the nature of health and nutrition; (2) the nature of vitamins; (3) general characteristics of fat-soluble and water-soluble vitamins; (4) the source and major role of several vitamins (vitamins C, B, D, E, and K) as well as deficiences that arise from their oversupply, or insufficiency; and (5) ways of preserving the vitamin content in raw food. Also included are several laboratory activities (listing materials needed and procedures used), questions to answer, a glossary, and a short list of references. (JN)

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Vitamins and Health

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Vitamins and Health

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VITAMINS AND HEALTH

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Vitamins and Health

In this day and age, the value of the peso is going down and the prices of everything, including food, are consequently going up. Thus it is wise to provide our families with the most nutritious foods which our shrinking budgets would only allow. The attainment of greater goals in life can be achieved with health as a basic prerequisite. It is only when an individual is healthy through proper nutrition that he can pursue noble objectives.

What is Health? Nutrition?

Health is defined as the complete social, physical and mental well-being of an individual and not merely the absence of disease and infirmity. The first step towards health is proper nutrition. Nutrition is the practice of taking in food containing substances essential for maintaining good health (Chaney et al., 1966).

Look at the 2 pictures shown in Figure 1. Which child looks healthy? A or B? As you go along, try to answer the questions preceded by a box (□).

Malnourished Child Normal Child

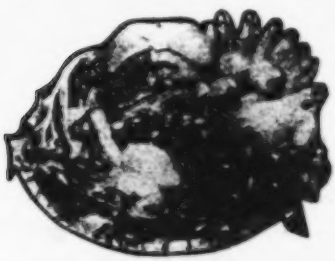
Fig. 1. Comparison between a malnourished child and a normal child

- ☐ Describe the physical appearance of Child A, Child B.

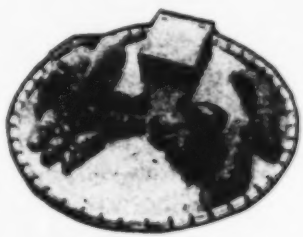
- ☐ State possible reasons why the appearance of Child A is different from Child B.

It is important to make the Filipino aware of proper nutrition. Eating the right kinds of food need not be expensive. As long as one is aware of the nutrients that food contains, choosing the right kinds of food and excluding foods that are not nutritious will certainly help to trim the budget.

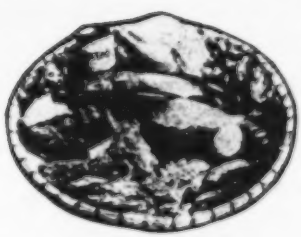
Figure 2 shows the basic foods needed for good health.



A. Glow Foods



B. Go Foods



C. Grow Foods

Fig. 2. Three basic food groups

- ☐ Which group/s is/are not usually a part of the foods you eat everyday?

A _____
B _____
C _____

☐ Check the reasons why this food group is not included in your diet.

_____ Not available in our community.
_____ No money to buy.
_____ Parents do not like to eat these.
_____ We are informed that we become more sick when we eat it.
_____ Others, specify.

The right kinds of food contain the right amount of nutrients. The macronutrients include proteins, fats and carbohydrates. These are needed by the body in large amounts. The micronutrients which include the vitamins and minerals are needed by the body in very small amounts. In fact, all the vitamins needed by a normal person in his lifetime could all be contained in a thimble. Vitamins are important to prevent the occurrence of a disease.

This module will discuss in detail the many kinds of vitamins, their functions and sources.

After reading this module, you should be able to

1. name the different vitamins;
2. identify the vitamins that come from plants, animals and those produced by microorganisms;
3. describe the function of each vitamin in the body;
4. state the symptoms of avitaminosis and hypervitaminosis;
5. perform a simple test for the presence of Vitamin C in some foods;
6. state the importance of vitamins in the daily diet.

If you take a closer look at advertisements for food products and health drugs, many claim that they contain the vitamins needed for a healthy body. Many people believe that if they eat properly, they would get all the vitamins required for normal body functions. Others still believe that the common ailments such as colds, coughs, etc. are due to a vitamin deficiency, and that these would be cured by taking in large amounts of synthetic (produced in the laboratory) vitamins, eating special diets, or avoiding this food or that drink. Such beliefs just show that many still do not know exactly what vitamins are and the roles they play in maintaining a healthy body.

It is, therefore, important to know what vitamins are and what they can do for the body. Once vitamins are understood and accepted then there is good reason for including them in one's daily diet.

What are Vitamins?

The name "vitamin" was coined by a Polish scientist, Casimir Funk, in 1912. Funk suggested that the major diseases that came out during his time like rickets, pellagra and beri-beri (Refer to Table 2 and Table 5 for descriptions of these ailments) were due to the absence of other nutrients in food which contain fats, carbohydrates and proteins. These missing nutrients, he further added, could give vitality or life to the body. His works sparked the interest of other scientists. As a consequence vitamins were identified, isolated and crystallized in many research laboratories all over the world. In short, vitamins became synthesized.

Vitamins are now known to be organic substances (carbon-containing substances) required in small, but significant amounts to support and maintain life. Most of these vitamins come from plant and animal food sources, with a few produced by bacteria normally growing in the intestines. These days, many natural vitamins exist in powder, pill, capsule, and liquid forms. This, in a way, ensures that one's dosage of vitamins can readily be available in the absence of the natural food sources.

The right amount of vitamins needed by the body is very small. Too much of any kind of vitamin is not good for the body. This is why the Food and Nutrition Research Institute (FNRI), a government agency, prescribes the recommended daily allowance (RDA) for each vitamin especially for those that have bad effects when taken in large amounts. This is shown in Table 1. The RDA is expressed as international units (IU) or in microgram (mg). Figure 3 shows foods rich in vitamins.

Fig. 3. Vitamin-rich foods

Table 1. Recommended Dietary Allowance (RDA) Per Day For Filipinos

Reference Person	Body Wt. Kg	Vitamin A Activity		Thiamine mg	Riboflavin mg	Niacin (mg equivalent)	Ascorbic Acid mg
		Retinol Equivalent mcg	I.U.				
Man:							
20–39 yrs.	56	650	4500	1.3	1.3	17	75
40-49 yrs.	56	650	4500	1.2	1.2	16	75
50-59 yrs.	56	650	4500	1.2	1.2	15	75
60-69 yrs.	56	650	4500	1.0	1.0	14	75
70 and over	56	650	4500	0.9	0.9	13	75
Woman:							
20-39 yrs.	48	550	3800	1.0	1.0	13	70
40-49 yrs.	48	550	3800	0.9	0.9	13	70
50-59 yrs.	48	550	3800	0.9	0.9	13	70
60-69 yrs.	48	550	3800	0.8	0.8	13	70
70 and over	48	550	3800	0.7	0.7	13	70
Infant: 6–11 mos.	9	250	1800	0.5	0.5	6	30
Child:							
1– 3 yrs.	13	250	1800	0.7	0.7	9	35
4– 6 yrs.	18	325	2300	0.8	0.8	11	45
7– 9 yrs.	24	400	2800	0.9	0.9	12	55
Boy:							
10–12 yrs.	32	500	3500	1.1	1.1	15	65
13–15 yrs.	44	550	4300	1.3	1.3	17	75
16–19 yrs.	55	650	4500	1.4	1.4	18	90
Girl:							
10–12 yrs.	35	500	3500	1.1	1.1	14	70
13–15 yrs.	44	550	4300	1.1	1.1	15	75
16-19 yrs.	48	550	4300	1.0	1.0	14	80
Pregnant (2nd and 3rd trimesters)							
13–15 yrs.		625	4300	1.5	1.5	18	120
16–19 yrs.		625	4300	1.4	1.4	17	120
20–39 yrs.		575	4000	1.4	1.4	16	120
40–49 yrs.		575	4000	1.3	1.3	16	120
Nursing: (1st 6 months)							
13–15 yrs.		975	6800	1.4	1.7	19	120
16–19 yrs.		975	6800	1.3	1.6	18	120
20–39 yrs.		975	6800	1.3	1.6	17	120
40–49 yrs.		975	6800	1.2	1.5	17	120
Nursing: (Next 6 months)							
13–15 yrs.		800	5600	1.4	1.5	18	120
16–19 yrs.		800	5600	1.3	1.4	17	120
20–29 yrs.		800	5600	1.3	1.4	16	120
40–49 yrs.		800	5600	1.2	1.3	16	120
Per Capita/day[1]		520	3612	1.0	1.0	14	67

[1] Based on 1977 population structure

Source: FNRI Publication No. 75
Revised, May 1977
Reprinted, June 1978

Fat-Soluble and Water-Soluble Vitamins

Have you heard of fat-soluble and water-soluble materials? How do you differentiate one from the other?

What happens to a pinch of salt crystals when placed in a cup of water? After a few minutes, the salt crystals disappear, right? This means that salt is water-soluble.

There are also vitamins that are water-soluble. They are found dissolved in the water portion of the blood and are circulated all over the body. Only very small amounts of these vitamins are kept in the body. There is no reported occurrence of overdose in water-soluble vitamins. This may be so because any excess is removed from the body.

Water-soluble vitamins include vitamin C or ascorbic acid and vitamin B complex.

The fat-soluble vitamins, on the other hand, must be dissolved in fat before they can be absorbed into the blood through the intestinal walls. Thus, the movement of fat-soluble vitamins in the body depends on the presence of an adequate level of fat in the diet. Some of these vitamins are stored in the liver. Bile, produced by the liver, and fatty acids from the digestion of fatty foods, serve as solvents in the absorption process. Bile transforms the fats into a form which permits more complete digestion by enzymes in the intestines and pancreas. The fat-soluble vitamins are vitamins A, D, E and K.

- ☐ Explain why it is difficult for a person with a liver ailment to acquire or synthesize the fat-soluble vitamins he needs.

- ☐ State the difference between water-soluble and fat-soluble vitamins.

- ☐ Explain why one does not suffer from an overdose of water-soluble vitamins.

The following activity will help you further in differentiating water-soluble and fat-soluble vitamins.

Activity 1. Getting to Know More About Water-Soluble and Fat-Soluble Vitamins

Materials:

1 vitamin C tablet (may be obtained from a drug store)
water
beakers or coffee jars and bottles
cooking oil, 10 mL
bile of fish (refer to Appendix for locating the gall bladder which contains the bile in the fish)

Procedure:

1. Place 1 vitamin C tablet in a jar of water. Observe what happens.
   - ☐ Was it soluble in water?

2. Squeeze out the fluid from the bile onto the beaker of oil by puncturing the organ with a needle or sharp object. What happens?
   - ☐ Was it soluble in oil?

3. Now dissolve a tablet of vitamin C in oil.
   - ☐ Describe what happened.

4. Squeeze a few drops of bile into a beaker/jar of water.
   - ☐ Describe your observation.
   - ☐ Which is water-soluble, bile or vitamin C?
   - ☐ Which is fat-soluble, bile or vitamin C?

Let us now consider in detail each of the vitamins – its source, major role and deficiencies that arise from its lack, oversupply or insufficiency. The terms avitaminosis (absence of) and hypervitaminosis (excessive amount of) are related to vitamins.

Water-Soluble Vitamins

Vitamin C or Ascorbic Acid

Of all the vitamins, vitamin C is one which cannot be synthesized by the human body. This is so because man lacks the enzyme necessary to produce this vitamin. The body requires about 70 milligrams of vitamin C daily.

- ☐ Compute how many micrograms of Vitamin C are needed daily by the body. (One milligram equals one thousand micrograms.)

Study the table below. It lists the good sources of vitamin C or ascorbic acid.

Table 2. Common Food Sources of Vitamin C

Source (100 grams edible portion, E.P.)*	Vitamin C Content (mg)	Source (100 grams edible portion, E.P.)*	Vitamin C Content (mg)
Fruits, fresh			
Anonas	90	Ampalaya leaves, boiled	3
Atis (sugar apple, *Anona squamosa*)	40	raw	76
Cashew (kasuy)	167	Cassava (tuber), boiled	156
Datiles (Jamaica cherry)	150	Gabi leaves, boiled	112
Guava (*Psidium guajava*)	158	Kangkong, boiled	11
Kalamansi (Phil. lemon)	45	raw	33
Kamatsili (*Aztec krosnockill*)	143	Malunggay, leaves, boiled	110
Mango (green)	70	Papaya, fruit, boiled	167
(ripe)	46	Singkamas pods	1056
Pomelo (suha)	47	Sitaro (sweet pea)	67
Rambutan	91	Sweet potato (kamote)	
Strawberries	112	tuber, white, boiled	41
Siniguelas	50	raw	44
Vegetables		yellow, boiled	27
Alugbati, boiled	85	raw	37
Ampalaya, fruit, boiled	40	tops, boiled	3
raw	78	raw	34
		Tomato, boiled	13
		raw	16

Source: FNRI, Food Composition Table, 1980, Bayan, Angelina et al., Composition of Forty Philippine Foods.
*edible portion (E.P.) – part that can be eaten

- ☐ From Table 2, which source/s of Vitamin C do you consume most? Do you think you are supplied with the sufficient amount that you need daily? Why?

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- ☐ Can you identify these fruits and vegetables if you see them in fruit/vegetable stalls?

- ☐ Which of these fruits and vegetables are grown in your garden? in your community?

Maybe you can bring samples of some of these fruits and vegetables in class, and use parts of them to perform Activity 2 of this module.

Specific Roles of Vitamin C in the Body

1. *Vitamin C prevents poisoning in the blood.* Normally, oxygen combines with the hemoglobin in the blood. In this way, oxygen is carried to all cells. Sometimes, carbon monoxide (CO), a poisonous gas, enters the blood. This gas combines with hemoglobin faster than oxygen does with hemoglobin. So, the cells are deprived of the much-needed oxygen. Cell death may even occur. Vitamin C helps to prevent this by giving off an oxygen atom (O) which is reactive. This oxygen combines with carbon monoxide forming carbon dioxide (CO_2). CO_2 is normally removed by the body as waste. This is why Vitamin C sometimes acts as an antitoxin.
2. *Vitamin C prevents scurvy.* Scurvy (Fig. 4) is a disease characterized by swollen and bleeding gums with loose teeth, slow wound healing, anemia, and painful joints. Such conditions are

Fig. 4. Gums with scurvy

due to the poor quality of collagen in our bodies. Collagen is a protein that supports the gums, teeth, muscles, and many other structures of the body. With vitamin C deficiency, the quality of collagen degenerates, thus causing scurvy.

3. *Vitamin C helps wound heal faster.* As mentioned earlier, collagen supports the muscles. In fact, muscle cells are made up mostly of collagen. The fast production of collagen is important for wounds, especially those caused by burns, to heal at a desired rate. With vitamin C, the enzyme for collagen formation is stimulated and production of new muscle cells proceeds faster.

- ☐ Explain how vitamin C helps in the healing of a wound.
- ☐ In your own words, explain how vitamin C prevents scurvy.
- ☐ Explain what vitamin C can do with the carbon monoxide that may enter the body.
- ☐ Go back to Table 2. Compare the vitamin C content of raw and boiled ampalaya leaves. What can you conclude about the effect of heat on vitamin C?

Other than heat, exposure to air and use of copper cooking utensils also destroy vitamin C.

Activity 2. Which Food Has Vitamin C?

Foods vary in their vitamin content. Furthermore, a certain food which has vitamin C contains this vitamin in varying amounts. This simple activity will help you determine which foods are rich in vitamin C. It will also help you find out the amount of vitamin C present in a specific food.

Materials:

balance
graduated cylinder
mortar and pestle

(4) 250 mL erlenmeyer flask
fruits and vegetables (banana, calamansi, guava, kamias, papaya, etc.)
fruit juice
hydrochloric acid (HCl), 1Molar (To prepare, add 8.3 mL concentrated HCl to 100 mL distilled H_2O)
iodine solution (tincture of iodine from the local drugstore)
10% starch solution (10 grams of cornstarch to 100 mL water)
(2) droppers (used medicine droppers)

Procedure:

1. For solid food samples, obtain the initial *mass* for each sample. Express in grams (g). For liquid food samples, obtain the initial *volume* for each sample. Express in milliliters (mL). Place each sample in a flask or coffee jar.
2. For each sample (solid or liquid), mix 2 drops of 1M hydrochloric acid thoroughly with the sample. Then add 1.0 mL starch solution.
3. Gently swirl the flask while adding iodine solution drop by drop until a purple or violet color persists. Note down the total number of drops for this color to persist.
4. To determine the vitamin C content of each food sample, divide the initial mass/initial volume of sample by the number of iodine drops. The lesser the number of drops used for the same amount of sample, the higher the vitamin C content.

$$\text{Vitamin C content} = \frac{\text{initial amount of sample in (g) or (mL)}}{\text{no. of iodine drops}}$$

5. Perform this test on a number of food samples and compare their vitamin C values. Arrange your food samples according to decreasing amounts of vitamin C content.

6. To record your data, construct a similar table as shown below.

Name of Food Sample	Initial Amount of Sample		No. of Iodine Drops	Vit. C Expressed as Initial Amount of Sample / No. of Iodine Drops	Rank
	Mass (g)	Volume (mL)			

Vitamin B Complex

Are you aware that there are many vitamins making up Vitamin B complex? For some time there was confusion as to the number and nature of the B-vitamins. However, many years of study have shed light on these complex group of vitamins.

Vitamin B complex is a term for all the B vitamins. It is useful to use this term since in nature, these vitamins are often found together.

Table 3 presents the members of the vitamin B complex. Take note of the function of each and the diseases that are related to their deficiency in the body.

Table 3. Summary of Vitamin B Complex Functions and Deficiency Diseases

Vitamin/Common Name	Function	Deficiency Disease
B_1 – Thiamine	acts as coenzyme in carbohydrate breakdown	beri-beri: characterized by wasting of muscles, circulatory failure, paralysis (Fig. 5)
B_2 – Riboflavin	acts as coenzyme in protein and lipid metabolism and in ATP generation	cheilosis: characterized by facial dermatitis, soreness, and wounds in the mouth area, eye irritations and wounds (Fig. 6)
B_3 – Nicotine	part of coenzyme in carbohydrate metabolism	pellagra: characterized by diarrhea, dermatitis, and mental disorder
B_5 – Pantothenic acid	part of coenzyme in carbohydrate metabolism	headache, fatigue, poor motor coordination, muscle cramps, gastrointestinal disturbances
B_6 – Pyridoxine	part of coenzyme in protein production	growth failure, convulsion in infants
B_{12} – Cobalamine	needed by the liver for proper red blood cell formation	pernicious anemia: characterized by variation in sizes of red blood cell due to abnormal red blood cell formation
Folic acid	facilitates the production of purines and thymine required for DNA synthesis	growth failure, anemia
Biotin	acts as coenzyme in fat, protein and carbohydrate metabolism	deficiency diseases in man are rare; in lower animals, deficiency is characterized by dermatitis

Fig. 5. Wasting of muscles

Fig. 6. Cheilosis, seen as lesions and fissures of the mouth

Most B-vitamins are coenzymes. Coenzymes are substances required for enzymes to function. Enzymes are substances that speed up chemical reactions in the cells.

Biotin, folic acid and cobalamine are produced by bacteria in the intestines. The other B-vitamins are found in plant and animal foods.

☐ Explain what will happen to biotin, folic acid and cobalamine when one takes in antibiotic or has diarrhea.

Table 4 gives a list of foods rich in vitamin B complex.

Table 4. Common Food Sources of Vitamin B Complex

red rice (boiled)	corn flakes
spaghetti	beef liver
macaroni	mungo bean (boiled mongo)
tamarind (ripe)	pork liver
kadyos (boiled pigeon pea)	carrots
peanuts (boiled)	small shrimps (alamang)
pork	squid
kangkong	anchovy (dilis)
eggs	clams
beef	crabs

Source: Food Composition Table, FNRI Handbook, 5th Revision, 1980. Manila.

☐ How much of these water-soluble vitamins do you need everyday?

To answer this, go over Table 5. Table 5 summarizes the prescribed amounts of vitamins B and C for children of your age.

Table 5. Recommended Vitamin B & C Allowance For Children Each Day

Age	Vitamin B			Vitamin C
	Thiamine mg.	Riboflavin mg.	Niacin mg.	Ascorbic Acid mg.
Child				
6 – 11 months	.5	.5	6	30
1 – 3 years	.7	.7	9	35
4 – 6 years	.8	.8	11	45
7 – 9 years	.9	.9	12	55
Boy 10 – 12 years	1.1	1.1	15	65
13 – 15 years	1.3	1.3	17	75
16 – 19 years	1.4	1.4	18	90
Girl 10 – 12 years	1.1	1.1	14	70
13 – 15 years	1.1	1.1	15	75
16 – 19 years	1.0	1.0	14	80

Source: Food Composition Table, FNRI Handbook, 5th Revision, 1980. Manila.

Fat-Soluble Vitamins

The fat-soluble vitamin group includes vitamins A, D, E and K. Fat-soluble vitamins can be stored in the liver in large amounts. Functions and deficiency symptoms of each fat-soluble vitamins are summarized in Table 6.

Table 6. The Functions and Deficiency Symptoms of Various Fat-Soluble Vitamins

Vitamins	Function	Effects of Its Absence Or Inadequate Amount
A (Retinol)	for good eyesight; growth of cells lining the membranes; normal growth of bones and teeth	not being able to see in the dark (night blindness); middle ear-infection; continuing diarrhea in old people; tooth caries; holes in the intestines; scaly and dry skin; if absence or insufficiency is prolonged, complete blindness may set in
D (Calciferol)	increases absorption of calcium and phosphorous for normal bone development	rickets characterized by enlarged ends of long bones, weak muscles and soft bones, deformed bones like bow-legs and knock knees (Fig. 8 and Fig. 9)
E (Tocopherol)	removes poisons from cells; for normal function of cell membrane	destruction of the cell membrane and sperm cells (sterility)
K (Quinone)	promotes blood clotting	longer time of blood to clot, hence, more blood loss (hemorrhage)

More About the Fat-Soluble Vitamins

Vitamin A

In a movie house, if it takes you more than 3 seconds to adjust to darkness, something may be wrong with your eyes. Think of the possible consequences of not being able to see in the dark. Vitamin A or

retinol prevents night blindness. Vitamin A prevents excessive dryness in the eyes which could lead to xerophthalmia or total blindness (Fig. 7). The good sources of this vitamin are fish, fish and animal liver oils, and butter. Vitamin A is not present in plants, but many vegetables and fruits (like carrots, sweet potato, squash) contain carotenoid pigments. These pigments consist of the pro-vitamin A which is changed to vitamin A in the body. Vitamin A is an important part of the visual purple in the retina of the eye. The retina consists of cells which are sensitive to light. This is why vitamin A is associated with good eyesight.

Fig. 7 Xerophthalmia, severe sign of Vitamin A deficiency

Full use of Vitamin A by the body is dependent upon the amount of Vitamin E and proteins present. Vitamin A is stored in the liver only when enough Vitamin E is present. On one hand, the distribution of Vitamin A to other parts of the body requires enough proteins. With insufficient proteins, Vitamin A remains unused in the liver. Consequently, the body then shows signs of Vitamin A deficiency.

Vitamin D

It has been a common belief that vitamin D comes from the sun's rays. This is not true Vitamin D or its initial compound (ergosterol) is found on the skin. With ultra-violet radiation from the sun's rays, this initial compound is changed into a form which is stored in the

liver. This form of vitamin D goes to the kidneys where it becomes most active, performing the following functions:

1. regulating the intake of calcium for bone mineralization,
2. maintaining the amount of calcium in the blood,
3. promoting the intake of calcium in the intestines, and
4. regulating the movement of calcium from intestines to the bones.

As can be seen from its functions, vitamin D is very much related to the use of calcium by the body. Since vitamin D is not found in living plant tissues, supplementary vitamin D is added to milk. You may look at your milk can label and see the phrase "Fortified with Vitamin D". This means that vitamin D has been added to the processed milk. Milk drinkers, therefore, are assured of an adequate supply of vitamin D.

☐ What is the role of the sun's rays in vitamin D metabolism?

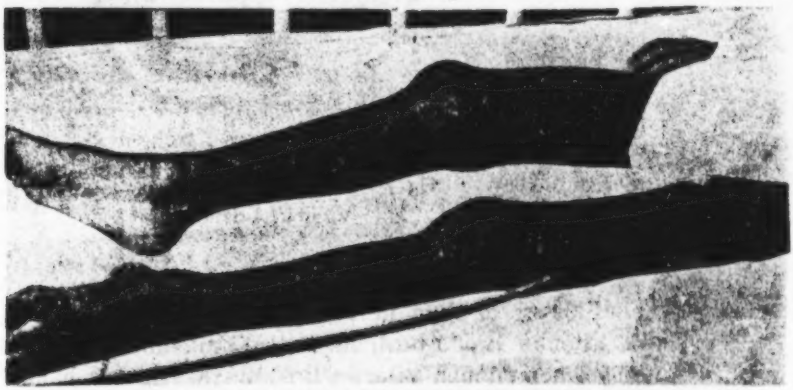

Fig. 8. Rickets, an early skeletal deformity that persists throughout life

Fig. 9. Rachitic rosary, the earliest sign of rickets

Vitamin E

In the course of normal body metabolism, certain harmful substances are always produced. These substances, when in small amounts are removed by the body as wastes. Eating too much of fatty foods yields these substances in amounts more than the body can get rid of. Accumulation of these substances destroy the cell membrane.

With sufficient amounts of Vitamin E, however, destruction of the cell membrane is minimized, if not stopped. Vitamin E has a special shape that makes it more attractive to these harmful substances. So Vitamin E binds with these substances. Accumulation of these substances is prevented thus protecting the cell membrane. In this manner, Vitamin E protects the sperm cells. Hence this vitamin is also known as anti-sterility factor.

Whole grains, cereals and vegetables are good sources of Vitamin E.

Vitamin K

Vitamin K is known as the anti-hemorrhagic vitamin. Its main function is to synthesize and maintain normal levels of prothrombin in the blood. Prothrombin is a substance from which thrombin is formed. The presence of thrombin in the blood gives the blood its ability to clot in areas where the skin is cut. Figure 10 shows the importance of vitamin K in blood clotting.

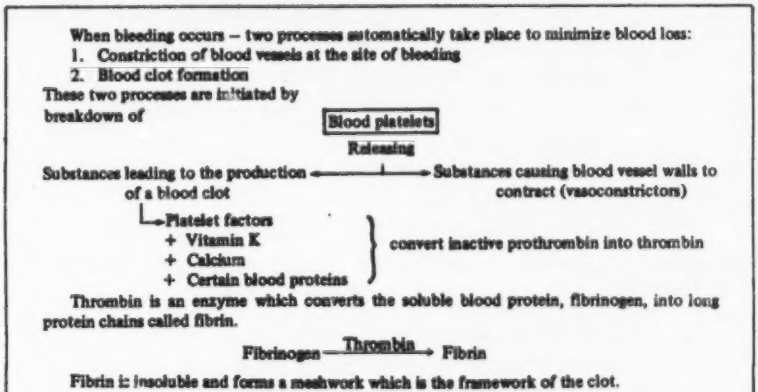
When bleeding occurs – two processes automatically take place to minimize blood loss:
1. Constriction of blood vessels at the site of bleeding
2. Blood clot formation
These two processes are initiated by
breakdown of
Blood platelets
Releasing
Substances leading to the production of a blood clot
Substances causing blood vessel walls to contract (vasoconstrictors)
Platelet factors
+ Vitamin K
+ Calcium
+ Certain blood proteins
convert inactive prothrombin into thrombin
Thrombin is an enzyme which converts the soluble blood protein, fibrinogen, into long protein chains called fibrin.
Fibrinogen —Thrombin→ Fibrin
Fibrin is insoluble and forms a meshwork which is the framework of the clot.

Fig. 10. Blood clotting and Vitamin K

Source: Farish, D., *Biology: The Human Perspective.* New York: Harper & Row Publishers, 1978, Fig. 5.4, p. 120.

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Vitamin K deficiency does not always occur because vitamin K is usually produced by bacteria in the intestines of man. Newborns may show signs of Vitamin K deficiency, but this persists only until enough bacteria have grown in their intestines.

There are some factors that prevent Vitamin K production by intestinal bacteria. These are:

1. Intake of antibiotics, e.g., penicillin, can kill the microorganisms.
2. Occurrence of diarrhea empties the intestinal tract of its contents including the microorganisms.
3. Intake of aspirin and sedatives (medicines that slow down the metabolic rate) also reduces the activity of Vitamin K-producing microorganisms.
4. A diseased liver will prevent the use by the body of Vitamin K because the liver is the site of Vitamin K uptake.

Effects of Excess Fat-Soluble Vitamins

Too much of anything is harmful. This also applies to fat-soluble vitamins. These vitamins can be stored in large amounts in the liver but sometimes excess amounts of these vitamins remain in the body. This will lead to a disease termed as hypervitaminosis. Hypervitaminosis in Vitamins A and D has been studied.

High doses of Vitamin A leading to hypervitaminosis A causes severe headaches, nosebleed, anorexia (loss of appetite), nausea, weakness and dermatitis. Bone formation ceases and existing cartilages are destroyed. This is because cellular membranes break down including the cellular membranes of lysosomes. Lysosomes are cell organelles that are known to contain enzymes that destroy other cellular components.

Hypervitaminosis D causes calcium ions to move away from bones and muscles. This results in increased calcium content in the blood. High levels of calcium in the blood form solid particles that cause blockages in the tiny tubes of the kidney. These particles are termed kidney stones or gall stones.

☐ Explain what will happen to cellular membranes with hypervitaminosis A.

☐ How does hypervitaminosis D affect the kidneys?

How Vitamin Content of Food is Lessened

Vitamins are sensitive chemicals. They are easily destroyed by heat, exposure to light, and exposure or contact with other chemicals. Many vitamins are lost or destroyed during the processing of food, both in the home and for commercial purposes. A large part of the vitamins is thrown away along with the peelings, the discarded outer leaves, and also in the cooking water where vegetables are boiled. See Table 2. Compare the vitamin contents of raw and boiled food.

VITAMINS ARE LOST WHEN THE WATER IN WHICH VEGETABLES WERE BOILED IS THROWN AWAY

Home preparation and cooking of food usually result in loss of 25-45% of the total nutrients. Folic acid and ascorbic acid are easily destroyed by heat and upon exposure to air.

Riboflavin is also destroyed by exposure to light.

WRAP BREAD WITH BROWN PAPER TO PROTECT ITS RIBOFLAVIN CONTENT

Heat also destroys thiamine. Cooking meat destroys 33-50% of this vitamin. Fat soluble vitamins are fairly resistant to processing losses.

Most vitamins are lost in the canning process because of high processing temperatures. Temperatures for killing bacteria and raw material preparation destroy varying amounts of vitamins depending on the kind of food and the length of processing time.

- ☐ Name the factors contributing to vitamin loss.
- ☐ Explain why some commercial synthetic vitamins are placed in dark bottles.

Ways of Preserving the Vitamin Content in Raw Food

Vegetables should be cooked in as little water as possible to preserve much of the vitamin content.

> COVER THE COOKING PAN WITH A TIGHT-FITTING LID TO SHORTEN COOKING TIME

Recent canning procedures make use of higher temperatures but shorter processing time. This practice permits more rapid destruction of bacteria and the retention of more vitamins and flavors.

Freezing as a method of keeping vitamins is not very popular but we should know that storage at about -17°C or below preserves nutritive values. However, temperatures of about -9.4°C and above will result in loss of vitamins A, C and E.

In cases where vitamin loss due to canning procedures cannot be prevented, food products are often fortified. This involves the addition of nutrients to the food product after processing. It was mentioned earlier that milk is commercially fortified with Vitamin D. Iodine is often added to salt and vitamin B complex to bread and flour.

Try to visit a supermarket and go to the canned and preserved food section. Examine the labels. Record the items labeled with fortified vitamins and minerals.

- ☐ Can you share the knowledge you now have about vitamins with family and friends? List the many ways you can do this.

GLOSSARY

absorption – the process by which water and dissolved substances pass into cells.
cell organelle – specialized structure present in the cell. Ex. nucleus, mitochondrion
constriction – tightening
deficiency – lack of, inadequacy, insufficiency
eliminated – removed
emulsify – to disperse an immiscible liquid in another to form a colloidal mixture called an emulsion.
fortified – strengthened with
molar – concentration of a solution expressed in moles of solute per liter of solution
retina – the innermost tissue layer of the eyeball containing light sensitive cells
toxin – poison produced by an organism that disturbs the metabolism in other organisms

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Appendix: Structure of a Fish